We claim

1. A method for determining an angular deviation of a charged particle beam, the method comprising the steps of:

providing a test object that comprises a structural element that has multiple sidewalls;

measuring a feature of at least one sidewall of the structural element;

changing the relationship between the charged particle beam and the test object;

measuring a feature of at least one sidewall of the structural element; and

processing the measurements to determine the angular deviation of the charged particle beam.

2. The method of claim 1 wherein the at least one sidewall measured during the first measuring step differs from the at least one sidewall measured during the second measuring step.

3. The method of claim 1 wherein a feature of at least a certain sidewall is measured during the first and second measurement steps.

4. The method of claim 1 wherein the measured feature is a width of a sidewall of the structural element.

5. The method of claim 1 further comprising a step of measuring the height of the structural element.

6. The method of claim 5 wherein the step of measuring the height comprises measuring heights of the structural element in multiple locations to provide multiple height measurements and statistically processing the multiple

height measurements to provide the height of the structural element.

7. The method of claim 6 wherein the amount of height measurements is responsive to a height measurement accuracy threshold.

8. The method of claim 5 wherein the measurement comprises an atomic force microscope measurement.

9. The method of claim 1 wherein the step of changing the relationship comprises introducing a relative movement between the charged particle beam and the test object.

10. The method of claim 1 wherein the step of changing the relationship involves introducing a relative rotational movement between the charged particle beam and the test object.

11. The method of claim 1 wherein during at least one measurement of a feature of a measured sidewall a measurement angle exceeds the sidewall angle and during at least another measurement of that feature the sidewall angle exceeds the measurement angle; whereas the measurement angle is defined between the charged particle beam and the measured sidewall.

12. The method of claim 1 further comprising a step of determining beam control parameters values in response to the angular deviation.

13. The method of claim 12 wherein the beam control parameters values comprise deflection unit current and voltage values.

14. The method of claim 12 wherein the beam control parameters values are calculated for different charged particle beam tilt states.

15. The method of step 12 further comprising calibrating charged particle beam deflectors in response to at least one charged particle beam coefficient.

16. The method of claim 1 wherein the structural element comprises two lines that are oriented towards each other by a first planar angle $\alpha 1$.

17. The method of claim 16 wherein $\alpha 1$ substantially equals ninety degrees.

18. The method of claim 1 wherein the test object comprises multiple structural elements and wherein the method further comprises measuring a feature of sidewalls of at least two structural elements to provide multiple measurements.

19. The method of claim 1 further comprising a step of locating the structural element by image base search.

20. The method of claim 1 wherein the charged particle beam can be positioned in multiple tilt states, and whereas the method further comprises determining the deviation angle of the charged particle beam for at least two tilt states.

21. The method of claim 1 wherein the charged particle beam is an electron beam.

22. The method of claim 1 wherein the charged particle beam is an ion beam.

23. The method of claim 1 wherein the angular deviation measurement is responsive to various inaccuracies.

24. The method of claim 23 wherein the inaccuracies comprise location inaccuracies, rotational inaccuracies, test structure angular non-uniformity and angular deviation measurement inaccuracies.

25. The method of claim 1 wherein the steps of measuring and changing are repeated to provide multiple angular deviation measurements that are processed to provide an angular deviation estimate.

26. The method of claim 25 wherein the amount of angular deviation measurements is responsive to various inaccuracies.

27. The method of claim 25 wherein the angular deviation measurements differ from each other by measurement locations.

28. The method of claim 1 wherein the measurements are performed at sidewall portions that are characterized by a small angular variation.

29. A method for determining an angular deviation of a charged particle beam, the method comprising the steps of:

providing a test object that comprises a structural element that has multiple sidewalls;

measuring a feature of at least one sidewall of the structural element;

introducing a rotational movement between the charged particle beam and the test object;

measuring a feature of at least one sidewall of the structural element; and

processing the measurements to determine the angular deviation of the charged particle beam.

30. The method of claim 29 wherein the measured feature is a width of a sidewall of the structural element.

31. The method of claim 29 further comprising a step of determining beam control parameters values in response to the angular deviation.

32. The method of claim 29 wherein the charged particle beam can be positioned in multiple tilt states, and whereas the method further comprises determining the deviation angle of the charged particle beam for at least two tilt states.

33. The method of claim 29 wherein the charged particle beam is an electron beam.

34. The method of claim 29 wherein the charged particle beam is an ion beam.

35. The method of claim 29 wherein the angular deviation measurement is responsive to various inaccuracies.

36. The method of claim 29 wherein the rotational movement is of about 180 degrees.

37. The method of claim 29 wherein the measurements are performed at sidewall portions that are characterized by a small angular variation

38. A method for determining an angular deviation of a charged particle beam, the method comprising the steps of:

providing a test object that comprises a first and second substantially equal structural elements, each structural element includes multiple sidewalls;

measuring a feature of at least one sidewall of a first structural element;

changing a relationship between the charged particle beam and the test object;

measuring a feature of at least one sidewall of the second structural element; and

processing the measurements to determine the angular deviation of the charged particle beam.

39. The method of claim 38 wherein the measurements are performed at sidewall portions that are characterized by a small angular variation.

40. A method for calibrating a charged particle beam system, the method comprising the steps of:

setting a charged particle beam to a certain tilt state;

determining calibrated beam control parameters values;

changing the certain tilt state and repeating the step of determining a calibrated beam control parameters.

41. The method of claim 40 wherein the step of determining calibrated beam control parameters comprises determining a relationship between angular deviation and beam control parameters values.

42. The method of claim 40 wherein the charged particle beam system is capable of being operated at multiple tilt states and wherein the steps of setting, determining and changing are repeated for at least two tilt states.

43. The method of claim 42 wherein calibrated beam control parameters values associated with a certain tilt state are used during calibrating the charged particle beam system during another tilt state.

44. The method of claim 40 wherein the charged particle beam is an electron beam.

45. The method of claim 40 wherein the charged particle beam is an ion beam.

46. The method of claim 40 wherein the angular deviation measurement is responsive to various inaccuracies.

47. The method of claim 40 wherein the step of determining calibrated beam control parameters values comprises measuring an angular deviation.

48. The method of claim 47 wherein measuring an angular deviation comprises the steps of: providing a test object that comprises a structural element that has multiple sidewalls; measuring a feature of at least one sidewall of the structural element; changing the relationship between the charged particle beam and the test object; measuring a feature of at least one sidewall of the structural element; and processing the measurements to determine the angular deviation of the charged particle beam.

49. The method of claim 48 wherein measuring an angular deviation comprises the steps of: providing a test object that comprises a structural element that has multiple sidewalls; measuring a feature of at least one sidewall of the structural element; introducing a rotational movement between the charged particle beam and the test object; measuring a feature of at least one sidewall of the structural element; and processing the measurements to determine the angular deviation of the charged particle beam.

50. The method of claim 48 wherein the measurements are performed at sidewall portions that are characterized by a small angular variation.

51. A method for determining an angular deviation of a charged particle beam, the method comprising the steps of:

providing a test object that comprises a first and a second structural elements that are oriented towards each other by a first planar angle $\alpha1$; whereas the first structural element has a first sidewall that is oriented

at a first sidewall angle $\beta 1$; whereas the second structural element had a second sidewall that is oriented at a second sidewall angle $\beta 2$;

measuring a feature of the first sidewall by scanning the first sidewall with a charged particle beam whereas the angular orientation between the charged particle beam and the first sidewall is greater than $\beta 1$;

measuring a feature of the second sidewall by scanning the second sidewall with a charged particle beam whereas the angular orientation between the charged particle beam and the second sidewall is greater than $\beta 2$;

measuring a feature of the first sidewall by scanning the first sidewall with a charged particle beam whereas the angular orientation between the charged particle beam and the first sidewall is smaller than $\beta 1$;

measuring a feature of the second sidewall by scanning the first sidewall with an charged particle beam whereas the angular orientation between the charged particle beam and the second sidewall is smaller than $\beta 2$; and

determining the angular deviation in response to the measurements.

52. The method of claim 51 further comprising a step of determining beam control parameters in response to the angular deviation.

53. The method of claim 52 wherein the beam control parameters values comprise a combination of deflectors current and voltage values.

54. The method of claim 52 wherein the beam control parameters values are calculated for different charged particle beam tilt states.

55. The method of step 52 further comprising calibrating charged particle beam deflectors in response to at least one beam control parameter.

56. A system for determining an angular deviation of a charged particle beam, the system comprising:

means for performing at least two measurements of a feature of a structural element of a test object whereas each measurement involves an interaction between the test object and a charged particle beam; and whereas the measurements differ from each other by a relationship between a charged particle beam and the test structure; and

means for processing the at least two measurements for determining the angular deviation.

57. The system of claim 56 whereas the means for performing comprises means for controlling the charged electron beam and detection unit for measuring particles resulting from the interaction.

58. The system of claim 56 further comprising a stage for changing the relationship by introducing a relative movement between the test structure and the electron beam.

59. The system of claim 56 wherein the relative movement is a relative rotation.

60. The method of claim 59 wherein the relative rotation is about 180 degrees.

61. The system of claim 56 further adapted to determine calibrated beam control parameters values in response to at least one measured angular deviation.

62. The system of claim 56 wherein the measured feature is a width of a sidewall of the structural element.

63. The system of claim 56 further adapted to determining beam control parameters values in response to the angular deviation.

64. The system of claim 56 capable of positioning the charged particle beam in multiple tilt states, and whereas the system is capable of determining the deviation angle of the charged particle beam for at least two tilt states.

65. The system of claim 56 wherein the charged particle beam is an electron beam.

66. The system of claim 56 wherein the charged particle beam is an ion beam.

67. The method of claim 56 wherein the angular deviation measurement is responsive to various inaccuracies.